

Mission Scientist Feedback and Outlook

D. G. Sibeck

Mission Scientist, THEMIS

Mission Scientist, Van Allen Probes

MMS Team Member

Soft X-ray Advocate

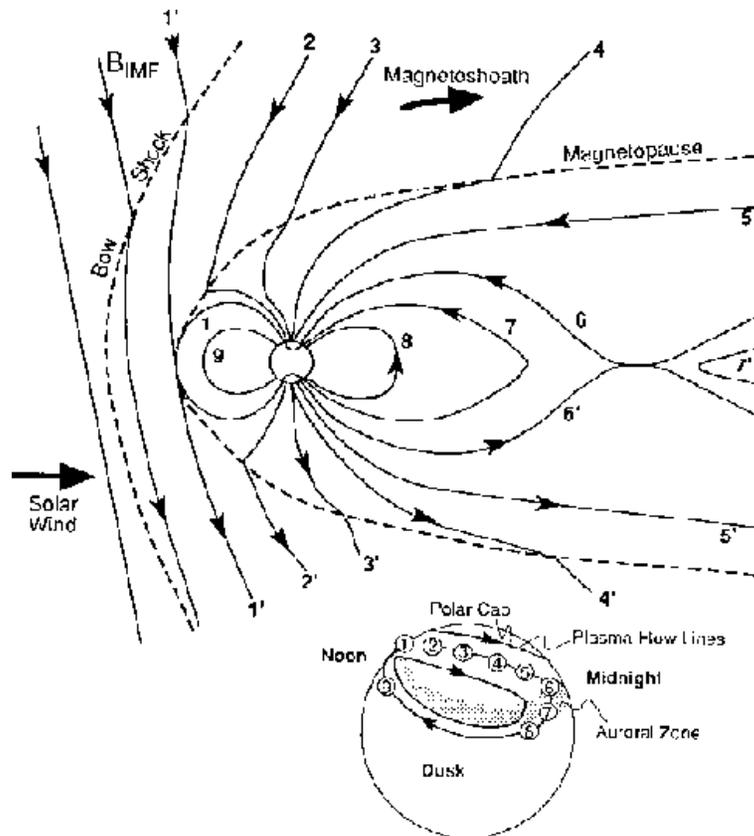
NASA/GSFC

Outline

- 1. Magnetopause erosion (THEMIS)
- 2. Injection and drift (Van Allen Probes)
- 3. Particle distributions associated with reconnection (MMS)
- 4. Soft X-ray emissions (SMILE and CuPID)

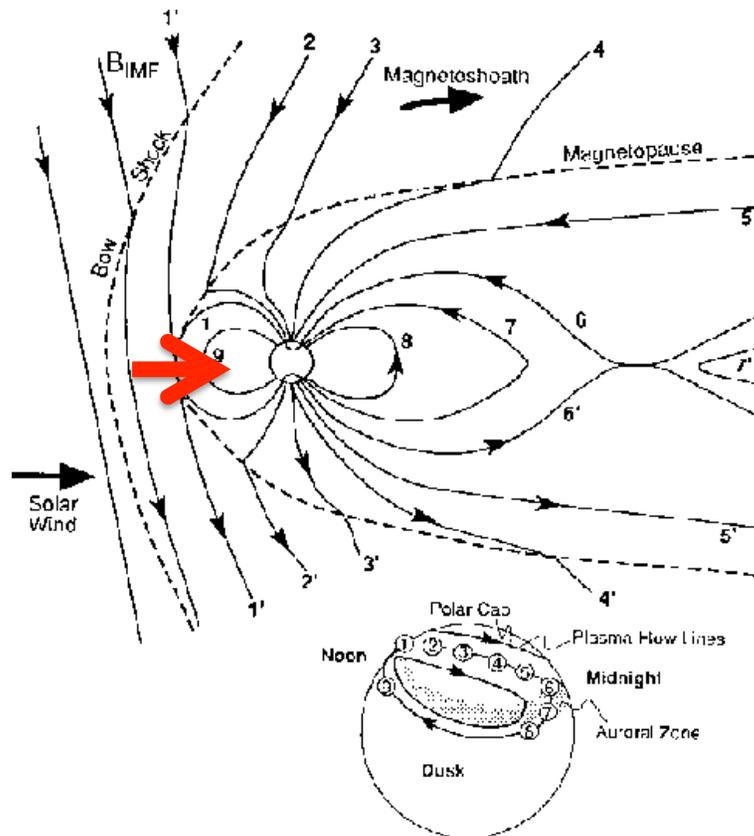
Erosion

- When the IMF turns southward, the dayside magnetopause moves Earthward: erosion



Erosion

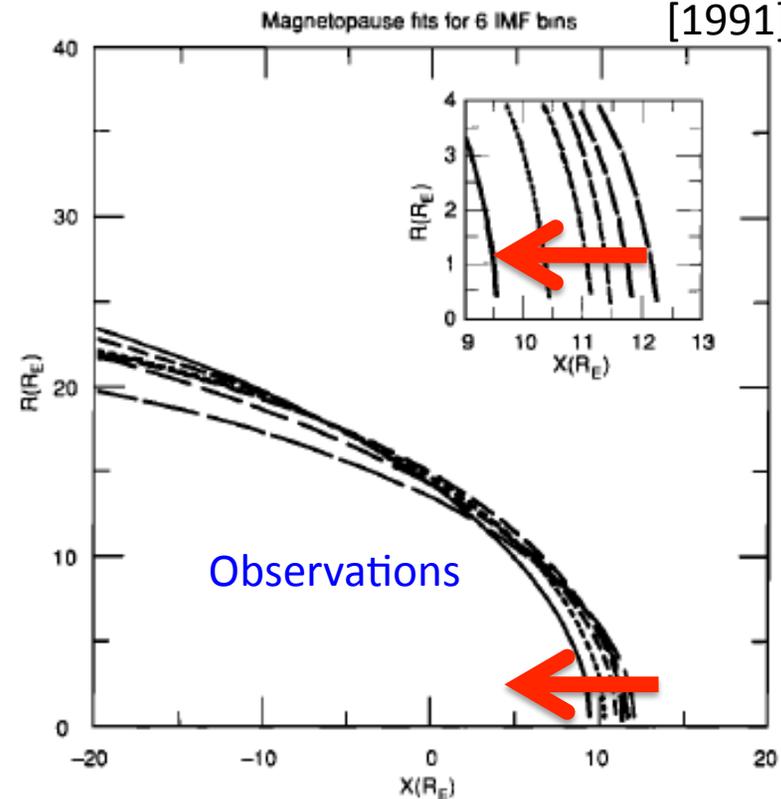
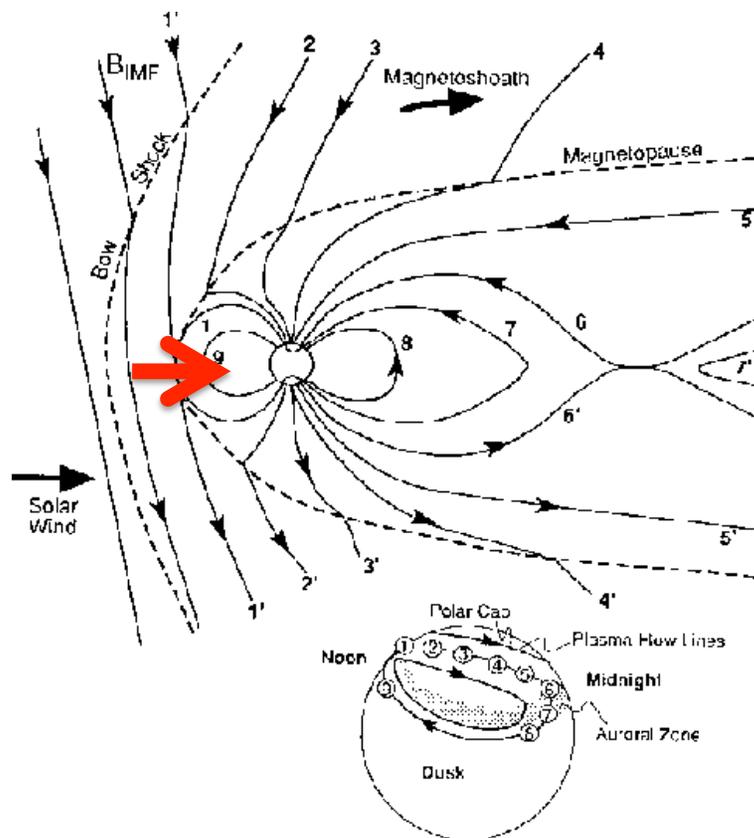
- When the IMF turns southward, the dayside magnetopause moves Earthward: erosion



Erosion

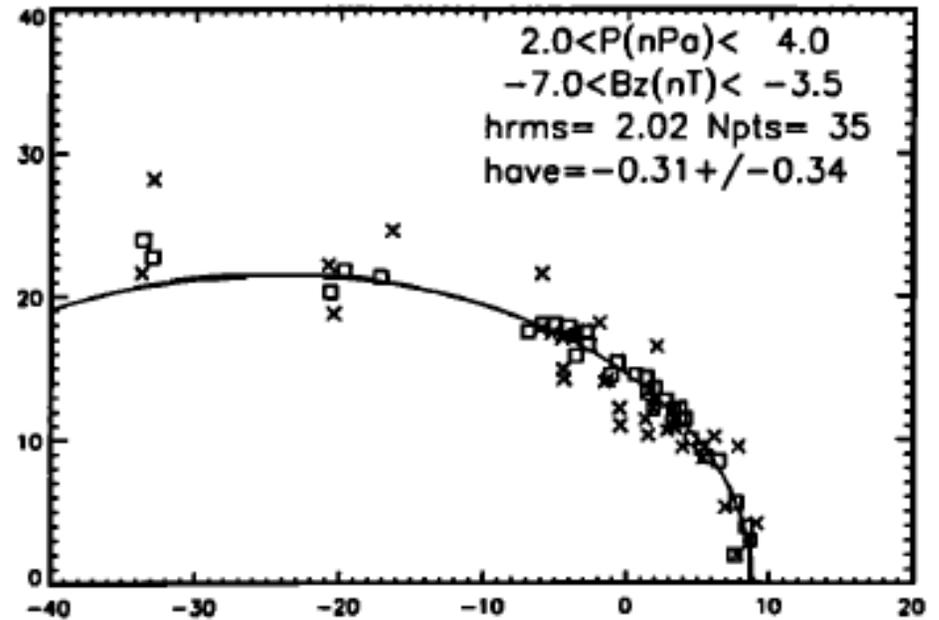
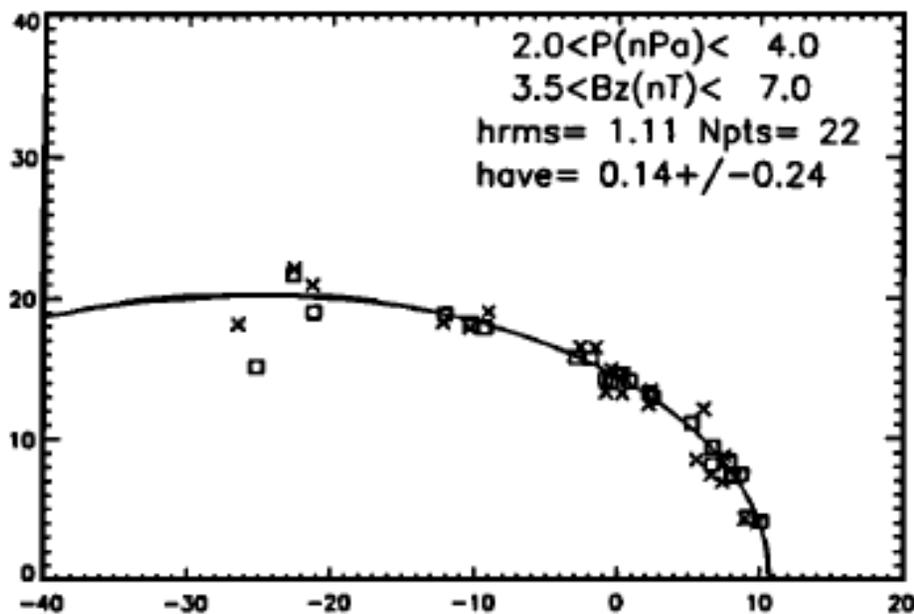
- When the IMF turns southward, the dayside magnetopause moves Earthward: erosion

Sibeck et al.
[1991]



Erosion

- But there is a lot of scatter...



Roelof/Sibeck

Erosion

- Does the scatter result from timing, averaging, lack of knowledge of solar wind conditions, **or something else?**

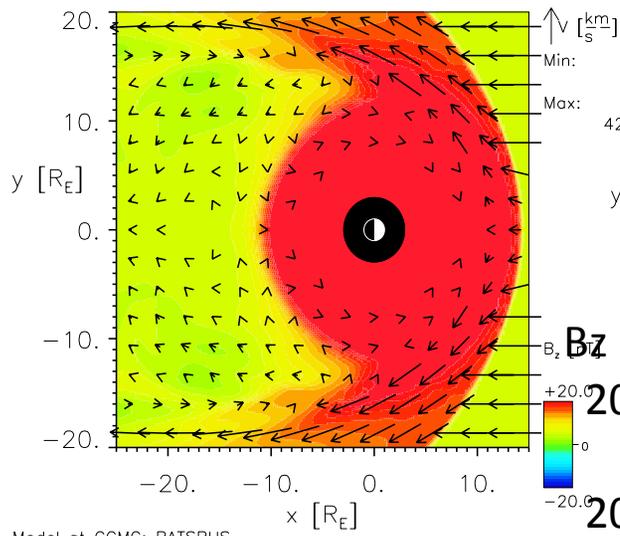
Equatorial Magnetosphere: V_x and B_z

0100 UT

$B_z = +5$ nT

Quiet Magnetosphere

01/01/2000 Time = 01:00:00 UT $z = 0.00R_E$

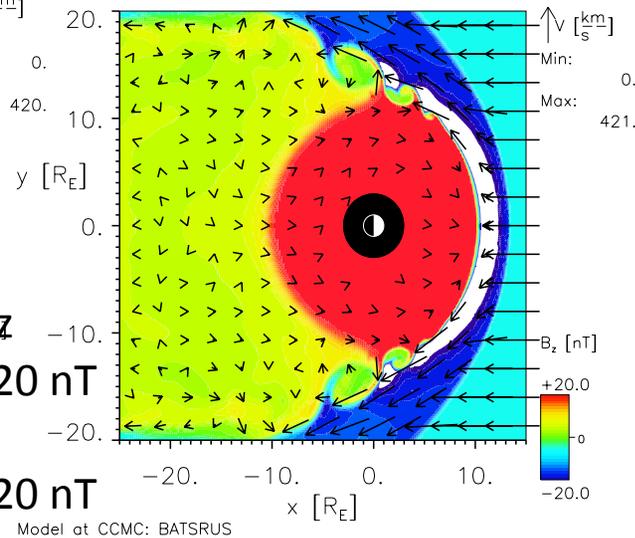


0130 UT

$B_z = -5$ nT

Dayside Reconnection/KH

01/01/2000 Time = 01:30:00 UT $z = 0.00R_E$

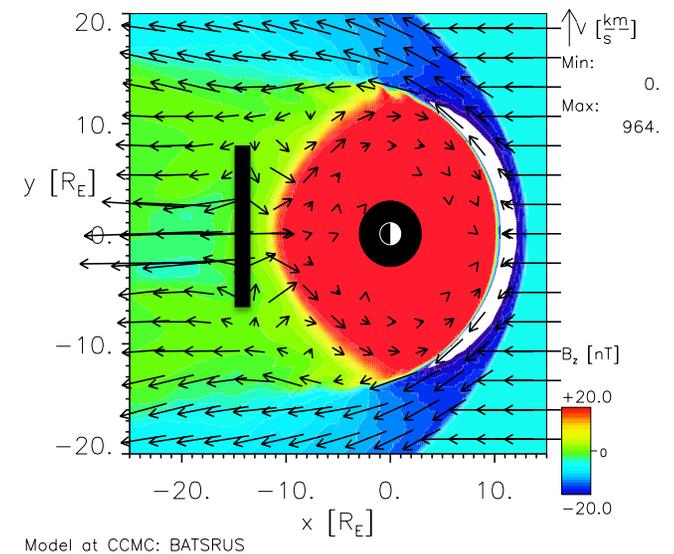


0230 UT

$B_z = -5$ nT

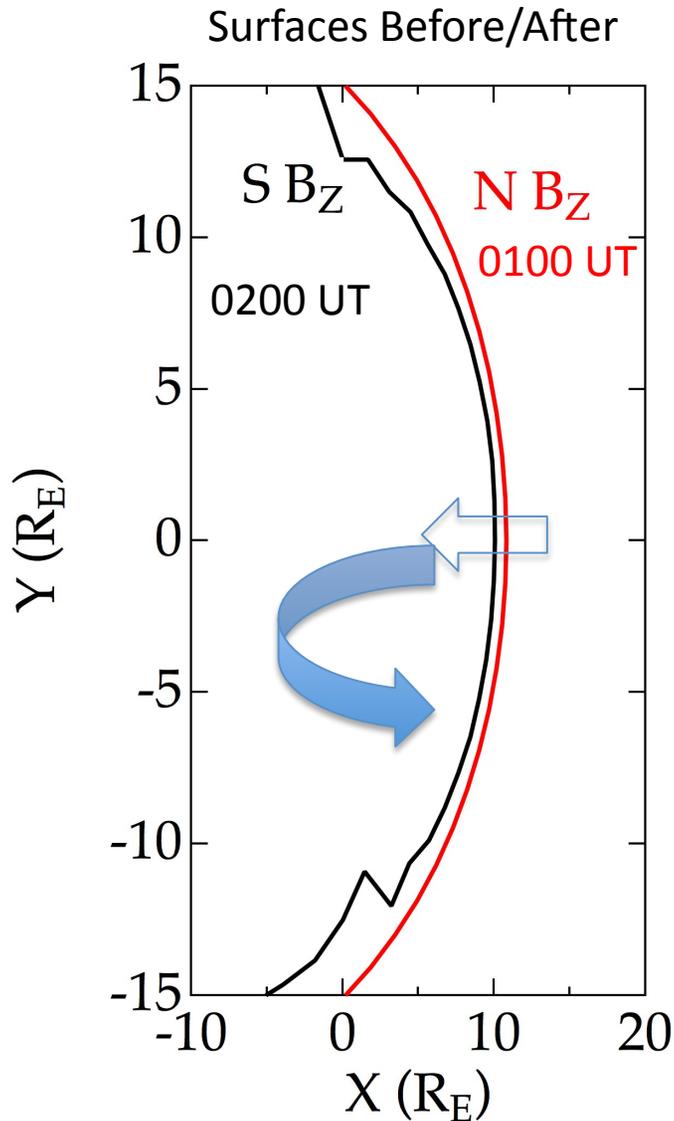
Nightside Reconnection

01/01/2000 Time = 02:30:00 UT $z = 0.00R_E$



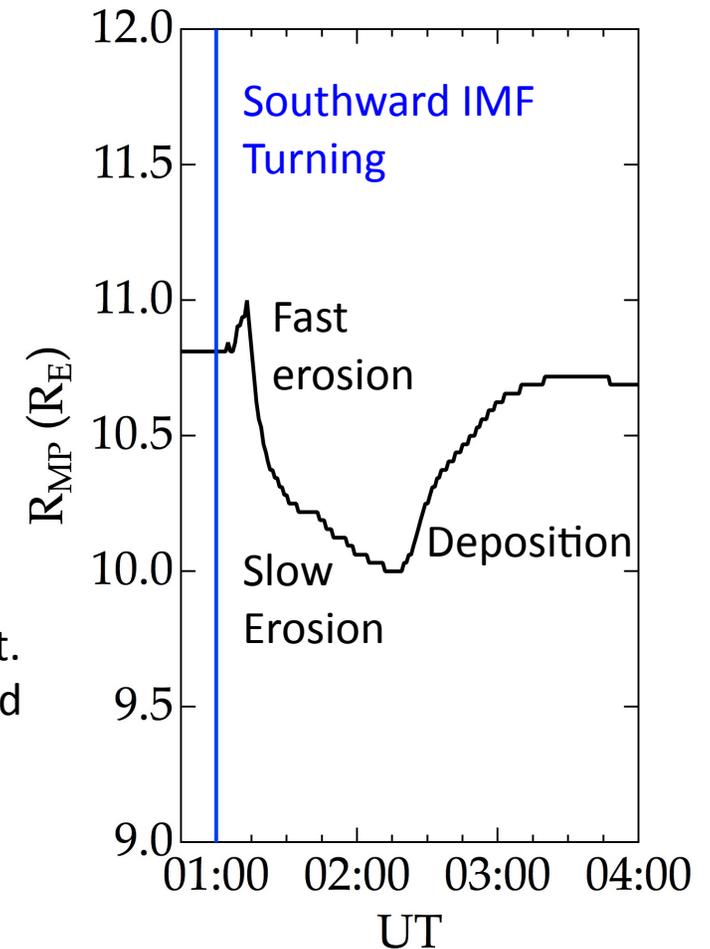
BATS-R-US run
At CCMC

Dayside Magnetopause Location In U. Michigan BATS-R-US Run



Two step erosion:
5 min fast, 60 min fast.
Abrupt increase at end

Subsolar Magnetopause

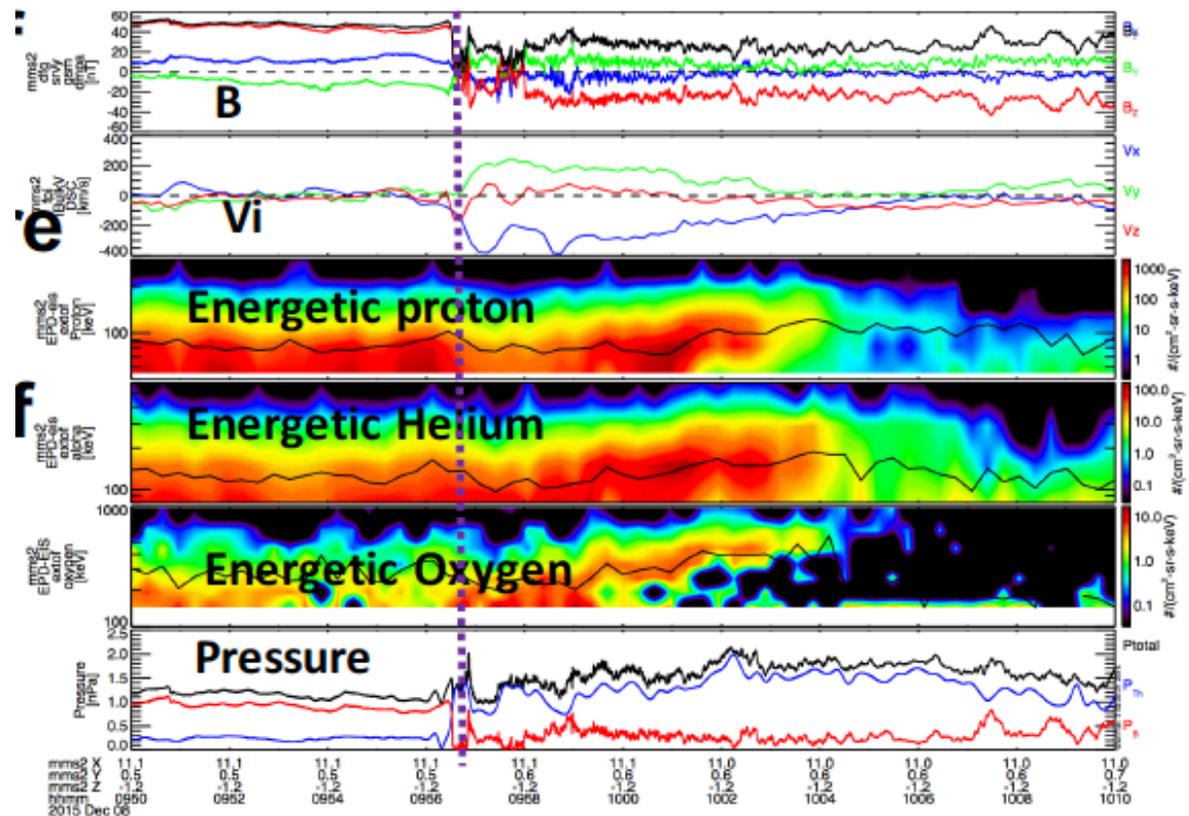


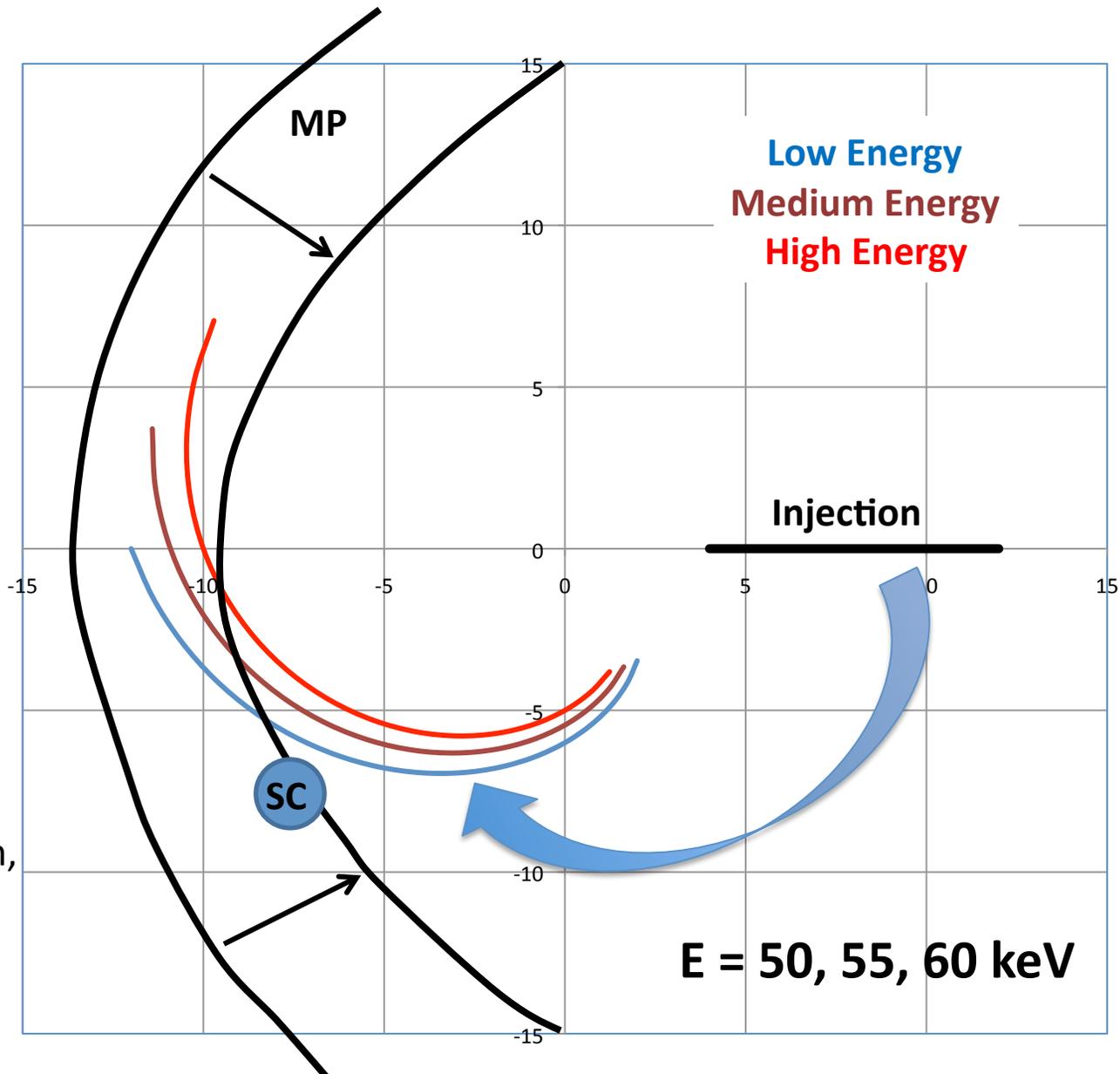
Global MHD Request

- Can currently see how parameters change along a line segment from point A to B over a time t_1 to t_2 .
- But spacecraft don't move linearly at a constant velocity.
- Upload ephemeris file and pick out simulation results at specified times and locations?

Injection and Drift

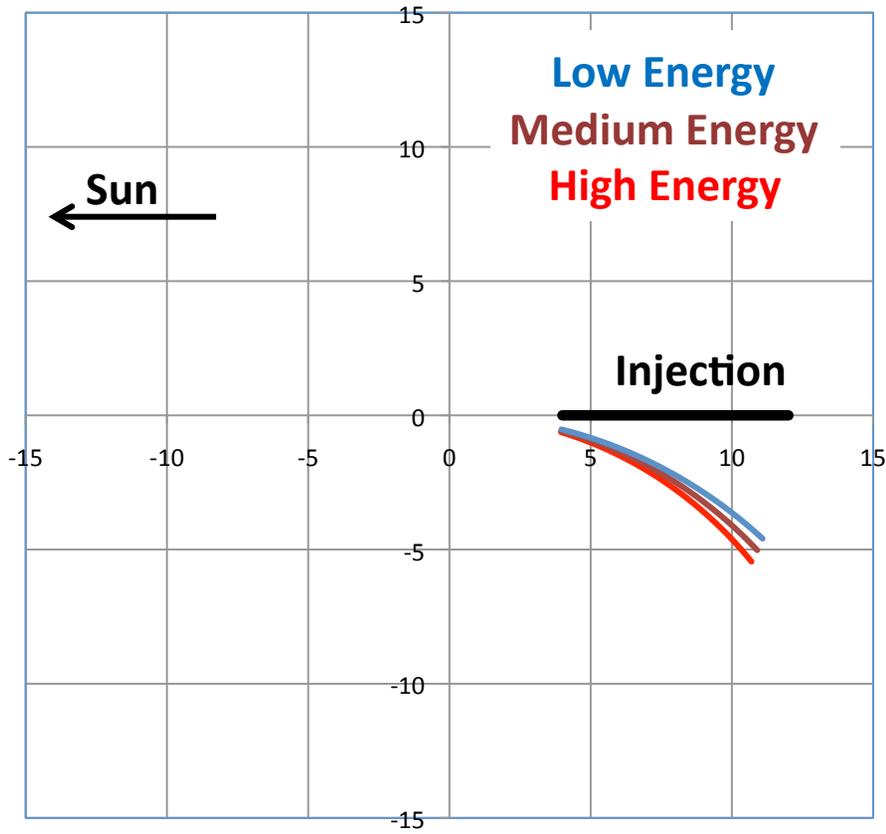
- Energetic Ion Dispersion Patterns at the Magnetopause [Lee et al., 2016]



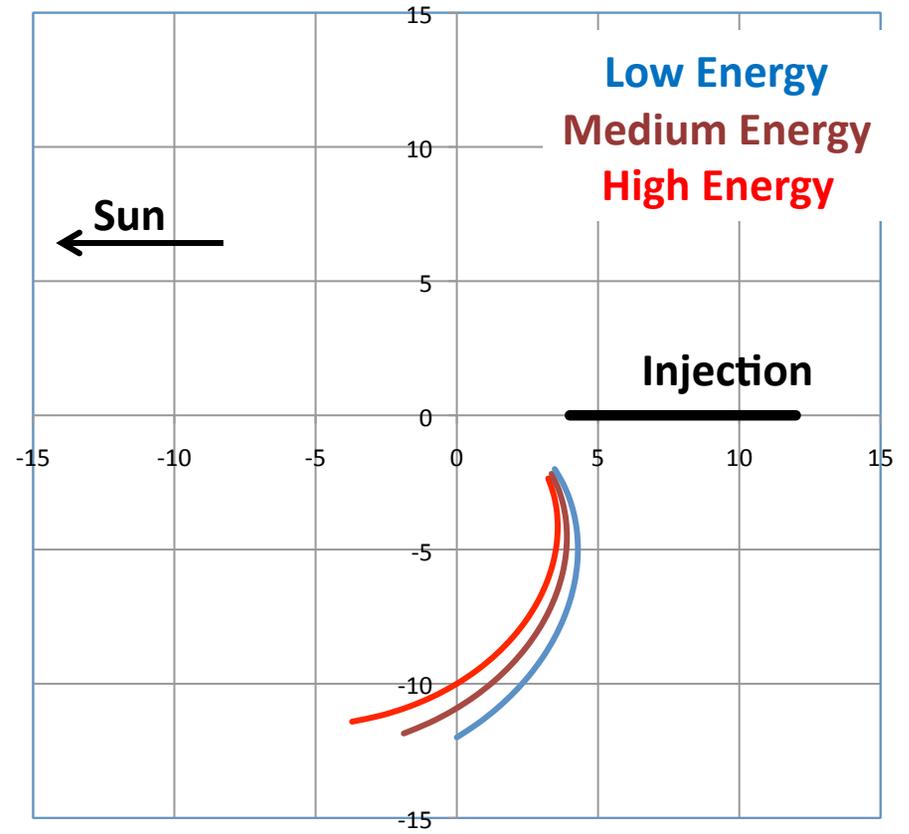


Mauk
 [Personal
 Communication,
 2016]

T = T1

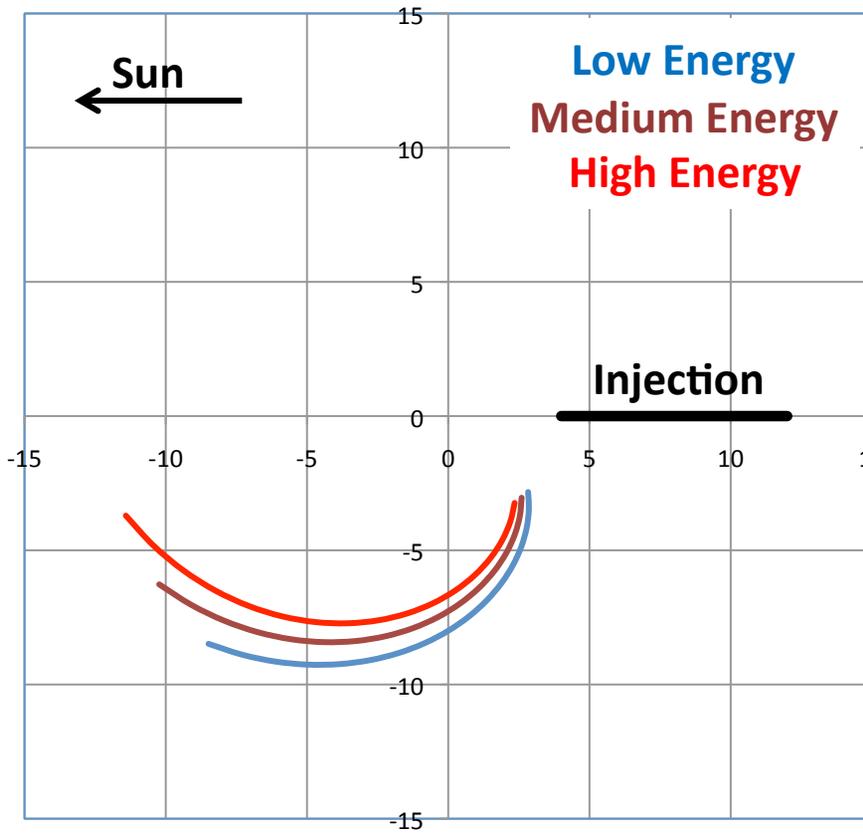


T = T2

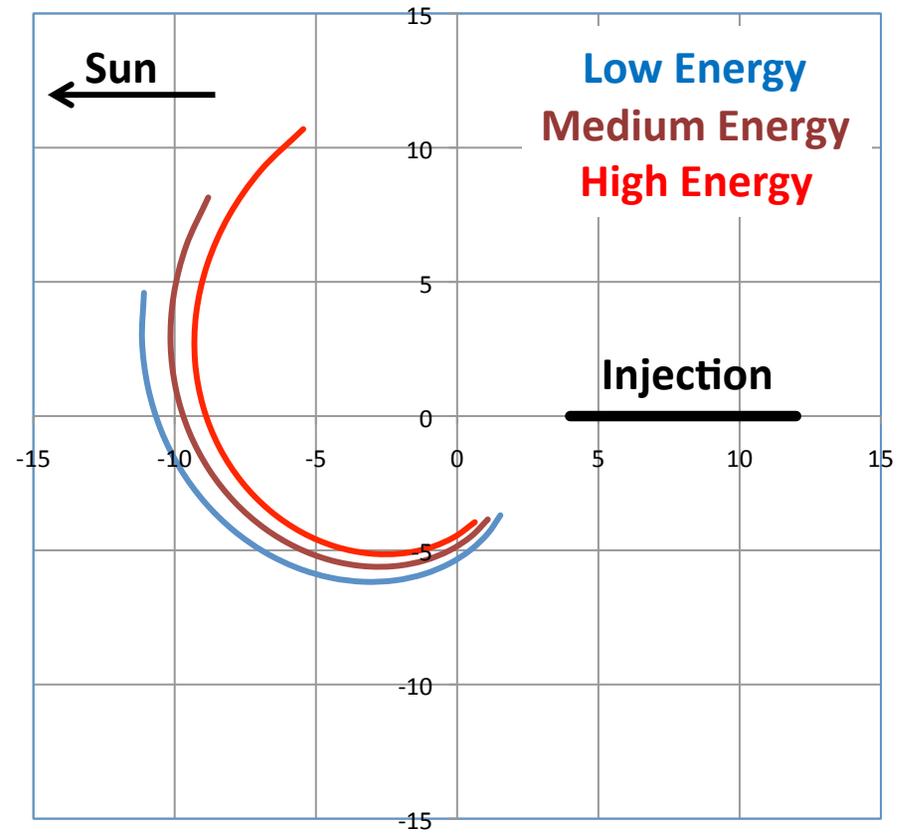


E = 50, 55, 60 keV

T = T3



T = T4



E = 50, 55, 60 keV

Injections and Dispersions

- Ability to track particles through evolving fields would be useful.....
- LANL instant model run gives L , L^* , I , B_M . Desire to reverse and trace motion of injections around magnetosphere.

Reconnection Microphysics



COMMUNITY
COORDINATED
MODELING
CENTER



[Related Links](#) | [Frequently Asked Questions](#) | [Community Feedback](#) | [Downloads](#) | [Sitemap](#)

[About](#) | [Models at CCMC](#) | [Request A Run](#) | [View Results](#) | [Instant Run](#) | [Metrics and Validation](#) | [Education](#) | [R2O](#)

[GEM Challenge](#) | [CEDAR ETI Challenge](#) | [GEM-CEDAR Challenge](#) | [SHINE Challenge](#) | [CME Arrival Time Scoreboard](#) | [Flare](#)

LOCAL PHYSICS SIMULATION RESULTS

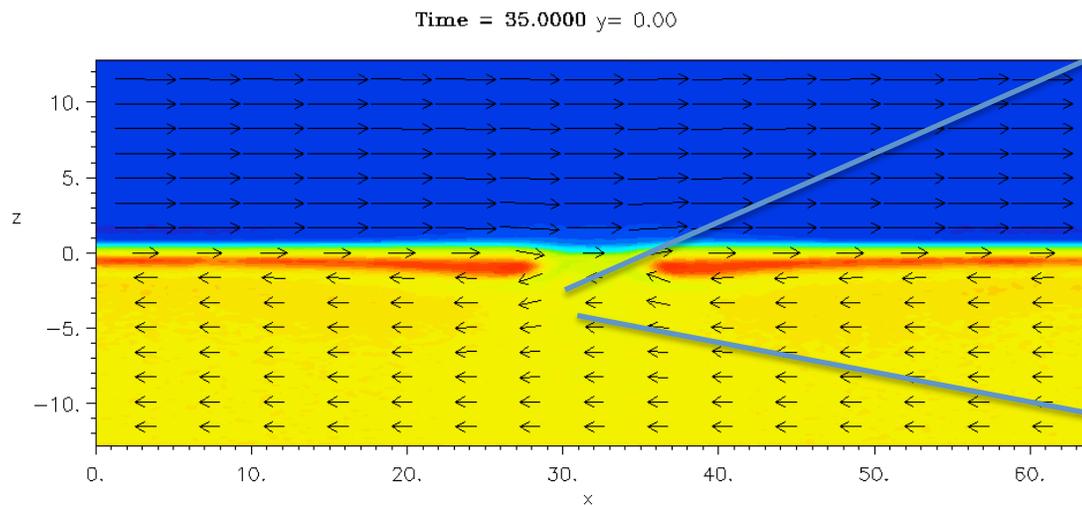
Perform [advanced search](#) or [simple search](#) in full database.

- [View ALL Local Physics Runs on Request](#)
- [View Runs for the following Model\(s\):](#)
 - PAMHD
 - PIC-Hesse
 - VPIC
 - P3D

[VIEW RUNS](#)

Reconnection Microphysics

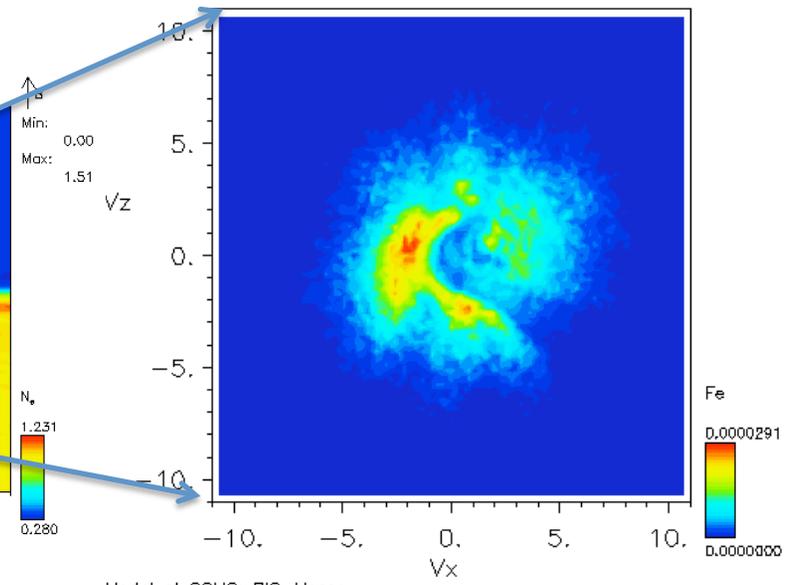
Density and Magnetic Field



Model at CCMC: PIC-Hesse

Electron Distribution Function

ROI: [30.5,31.1,-0.4,-0.3] Time = 35.0000 $v_y = 0.00$



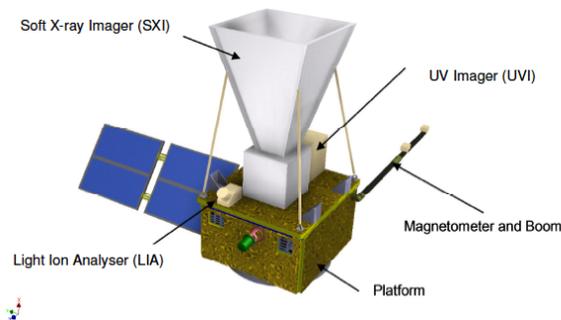
Model at CCMC: PIC-Hesse

Reconnection Microphysics

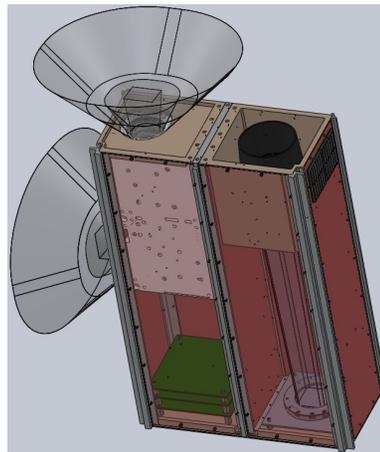
- Great
- Add more runs...and/or runs on request?

Soft X-rays

- ESA's SMILE and NASA's CuPID missions are predicated upon the ability to construct global images of the magnetosphere from the soft X-rays generated when high charge state solar wind ions encounter exospheric neutrals.

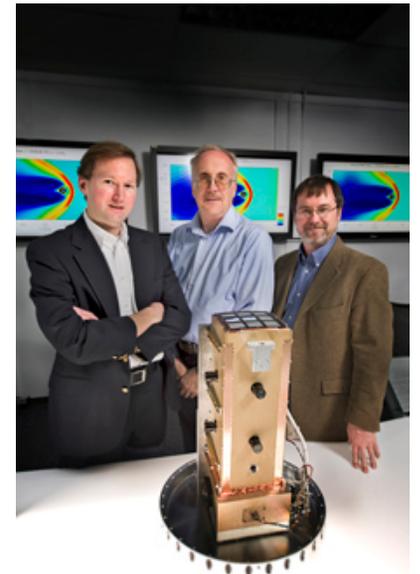


ESA SMILE

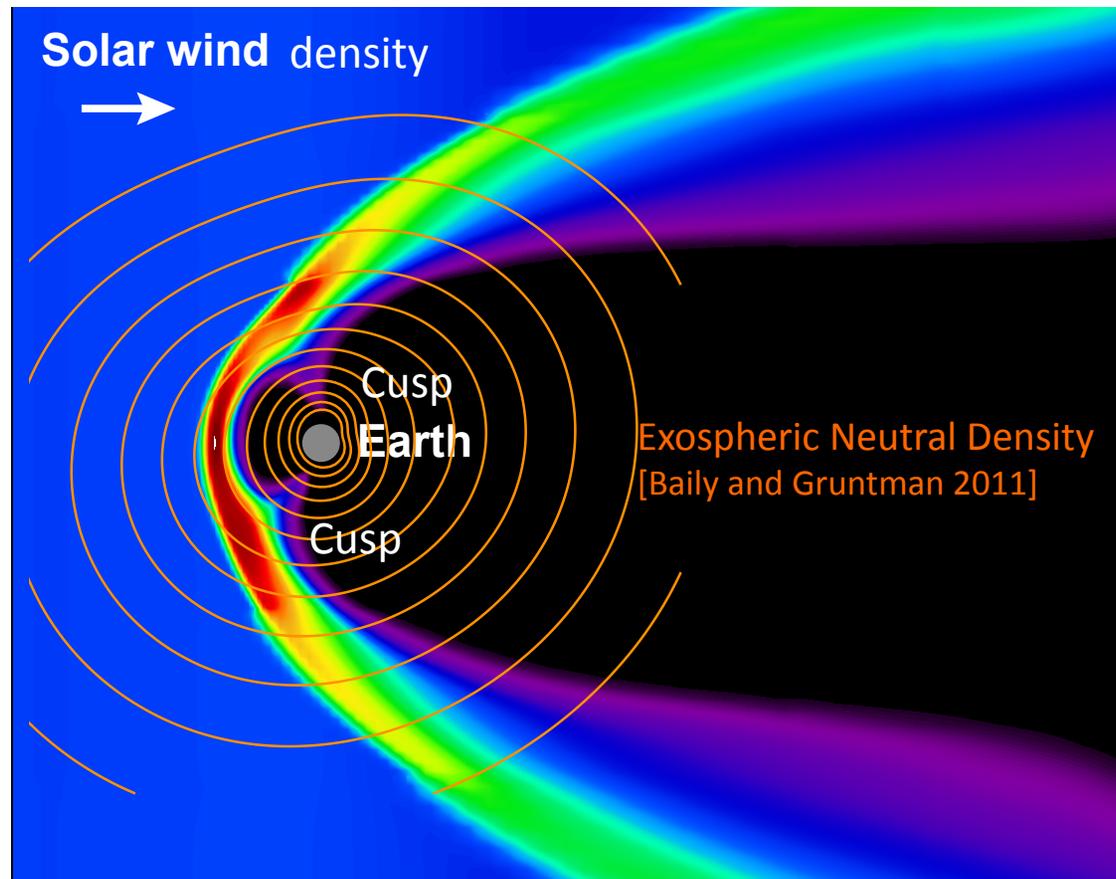


HTIDES CuPID

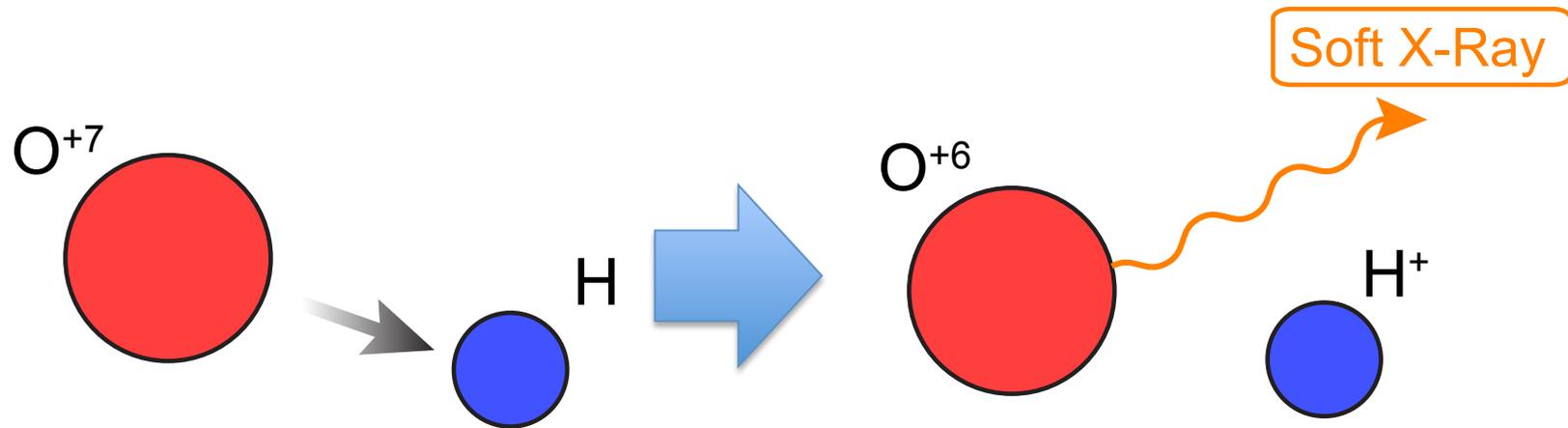
Only soft X-ray
Imager to have
Flown in space
To date...



Solar Wind Plasma Encounters Earth's Atmosphere in the Region of Interest



Solar Wind Ions Emit Soft X-rays when they Encounter Exospheric Neutrals



Sample Charge Exchange Interaction

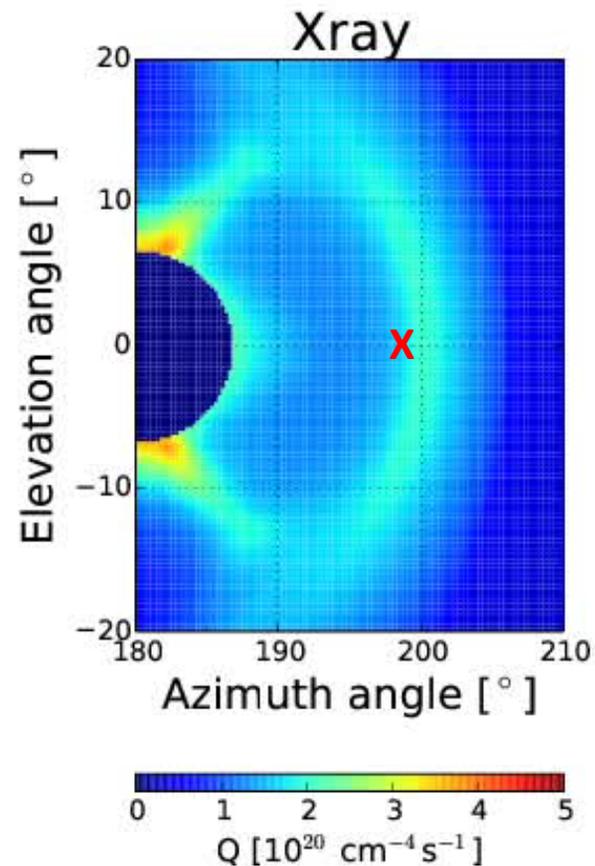
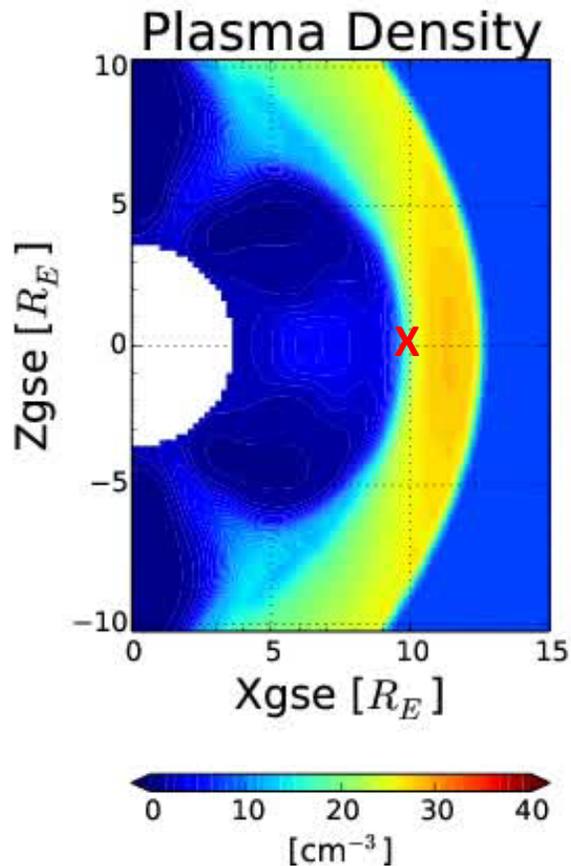
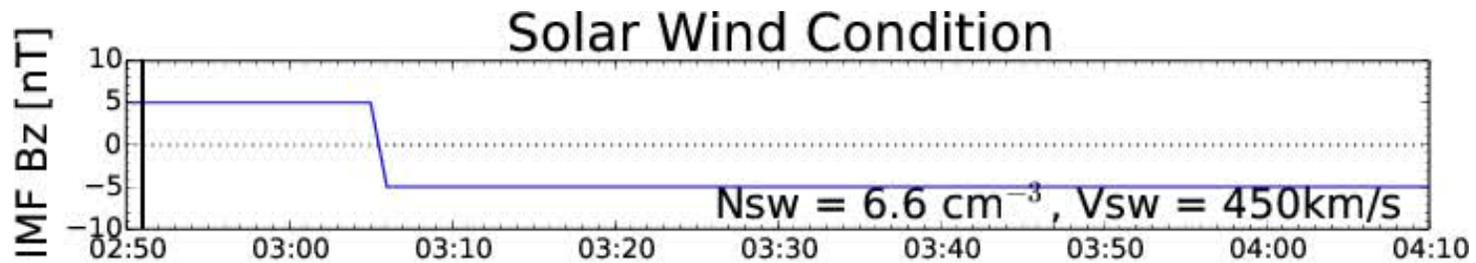


0.1-2keV

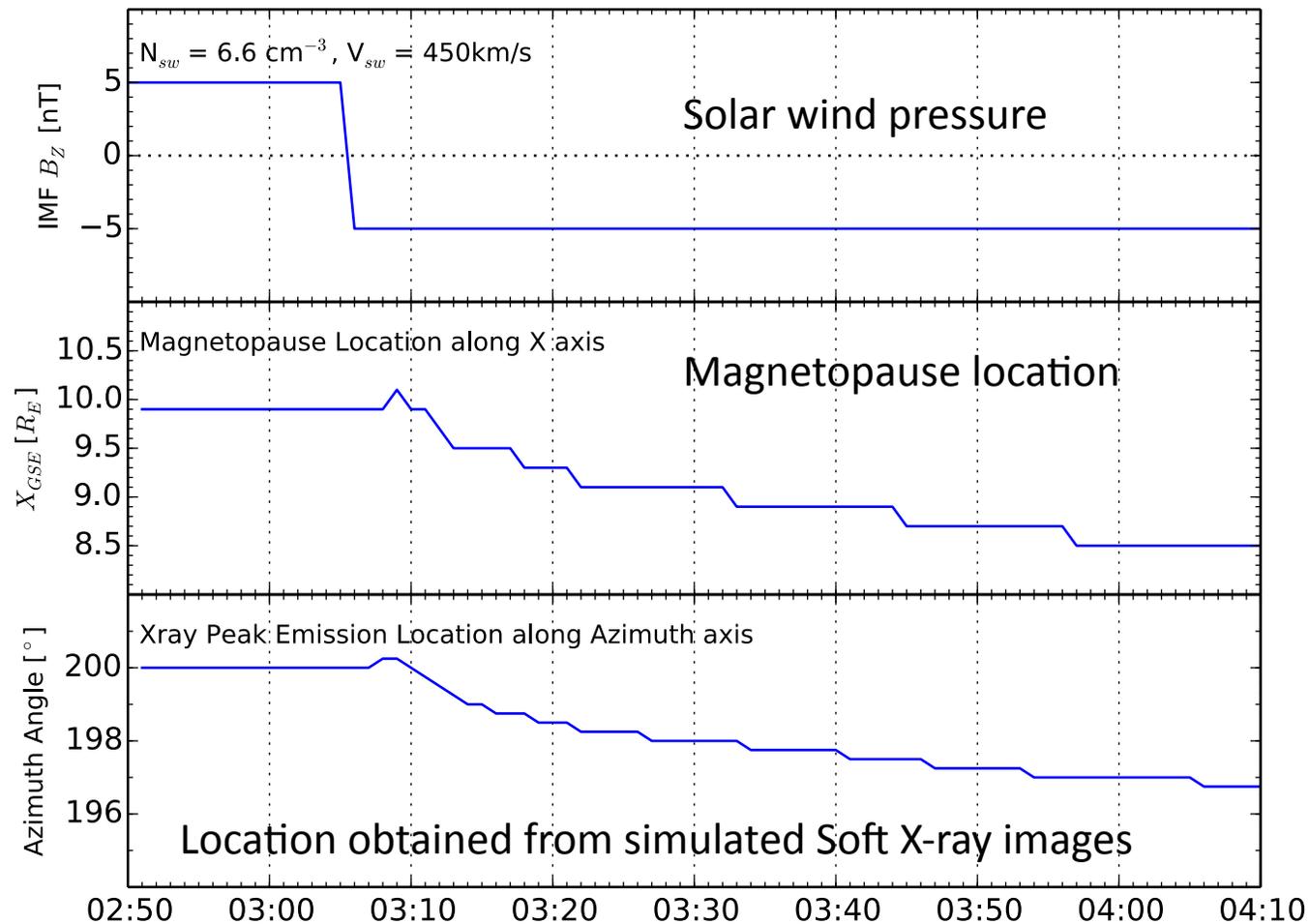
Signal:

$$\int_0^\infty (n_n n_{swp} v_{rel} \langle \sigma \rangle fb) \frac{d\Omega}{4\pi} dl$$

We Simulate SW Events: e. g. Response to Reconnection Onset



We Spot and Track Boundaries in the Images



Summary

- There is still a lot to do...
- But it just keeps getting better and better

Data Product

- Van Allen Probes
 - LANL instant model run gives L , L^* , I , B_M . Desire to reverse and trace motion of injections around magnetosphere.
- THEMIS
 - You enter start/stop times, positions and see plots of parameters along trajectories, but real trajectories don't move linearly with time (upload ephemeris and times)
- MMS
 - Compile a bigger library of run conditions, distribution functions for PIC codes
- Coordinate transform: AACGM, Apex, but what about GSE-GSM, SM etc?